

Improving Virtual / Constructive Training and Experimentation with Human Adjudication

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ABSTRACT

During constructive and virtual training and experimentation, circumstances exist when human intervention is required to override the outcomes of the computer simulation or to change the state of the simulation. Some examples of human intervention include adjudication of engagements having unreasonable outcomes, changing supply levels, and moving units or individual entities within the battlespace. Overriding the simulation results during event execution should not be a spontaneous decision. If done randomly or without established, well briefed procedures, the training audience or experiment participants will lose confidence in the validity of the computer model. During event execution, the results of human intervention can cause confusion on the part of participants, give unfair advantages (perceived or actual) to one side or another and corrupt data collection. Additionally, these interventions must be performed in a timely manner to have their desired effect. For these reasons, management must implement well reasoned adjudication procedures. For the 2011 Joint Forcible Entry Warfighter Experiment (which included US Army, Air Force, Navy and Marine forces operating in a distributed, constructive simulation over two weeks), the Experimentation Environments Branch of the Army's Maneuver Battle Lab developed a set of procedures to provide guidance when simulation outcomes will be changed or when human intervention into the simulation is appropriate. This paper provides analysis from the execution of the experiment of how these procedures impacted experiment objectives and post-experiment data analysis. Discussion includes how data collected from the High Level Architecture (HLA) logger and Damage Effects Server was used to make intervention decisions and reasons for human override of the simulations. The paper closes with lessons learned during this event that can be applied by others in the training and experimentation community of practice.

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INTRODUCTION

The purpose of this paper is to present a methodology for determining when, and under what conditions, humans should reverse the outcomes of computer simulations through an adjudication process. From the outset, it is important to note that adjudications or changes made to the outcomes of computer simulations can never be done to influence results or change conditions in order to influence analytical outcomes. Readers are encouraged to adapt the procedures outlined in this paper for their own experimentation and training events. It must be remembered that key components of the process are the determination of procedures prior to event execution and the full accounting of adjudication is recorded in an open process.

It is said that all models are imperfect. When using models and simulations for training and experimentation, leaders must develop procedures to account for shortcomings in the models. These procedures cannot be arbitrary; they must be predictable and understood by all participants. In most training and experimentation events, leaders simply decide how to account for model shortcomings as they arise in execution. Although this technique is perceived to be the most expedient manner to resolve problems, in practice there is normally time to list the decision making process, which may affect experiment or training outcomes. Additionally, in most cases the procedures are inconsistent, undocumented, and result in reduced confidence on the part of the participants in the simulation or model. This paper has four purposes. First, to substantiate the requirement for adjudication procedures for all training and experimentation events. Second, to present a framework for establishing adjudication procedures. Third, to identify the procedures for executing the procedures and who should execute them. Fourth, to present lessons learned from using the procedures during Joint Forcible Entry Warfighter Experiment (JFEWE).

In order to illustrate the concepts that I will outline in this paper, I will use the March 2011 JFEWE as an example of how these procedures were used, and will illustrate both good and bad examples of the use of the procedures during that experiment and the lessons currently being learned from their use.

JFEWE Construct

As summarized in the JFEWE Final Report, JFEWE was an experiment held in March, 2011. It involved 496 participants directly associated with experimentation execution. It was an Army Concepts and Integration Directorate (ARCIC)-directed, integrated warfighting experiment with the Maneuver Battle Lab (MBL) assigned as the executive agency for planning and execution. The JFEWE was a concept development constructive and virtual simulation experiment focused on Forcible Entry (FE) doctrine and concepts. Its goal was to examine Joint and Army capability to conduct FE operations by amphibious assault, airborne assault, and air assault into austere locations to overcome or avoid enemy anti-access and area denial efforts, and to present the enemy with multiple threats from unexpected locations. JFEWE provided insights to the FY 11/12 Army Warfighting Challenges (WfC) and to the development of the Joint Operational Access Concept (JOAC) and Army Operational Concepts (AOC). This effort provided concept writers and doctrine developers with feasibility feedback for the refinement of their Functional Concepts as well as identifying required capabilities in the 2018 time frame, which informed Doctrine, Organizational, Material, Training, Personnel and Facilities (DOTMLPF) integrated solutions across warfighting functions. The chart from the Final Report on page 2 shows the overall JFEWE Federation and the functions of each location.

JFEWE Experiment Objectives

The Maneuver Battle Lab, in conjunction with the community of practice, identified the following ARCIC-approved Experiment Objectives:

1. Focus on the operational problem of Anti-Access with a significant tactical force (Multiple BDEs/DIV force).
 2. Critically explore and assess concept supporting ideas and required capabilities in challenging operational environments to revise Army concepts to drive capability development in the 2018-2026 timeframe.
 3. Economize the Army Experimentation Plan by integrating events using a consistent campaign scenario and consistent Models and Simulations Federation.
4. Inform US Army Forces Command contingency force operations requirements and capabilities.
 5. Incorporate Division Command Posts play into the experiment.
 6. Conduct the experiment within a joint context/problem to inform and exercise Joint Forces Command's (JFCOM) draft JOA Concept.
 7. As part of the same complex environment utilize the same or similar scenarios in the various venues.
 8. Develop a campaign plan context for forcible entry employing tactical forces (Multiple BDEs/DIV) with Division and Corps Command and Control (C2) requirements.

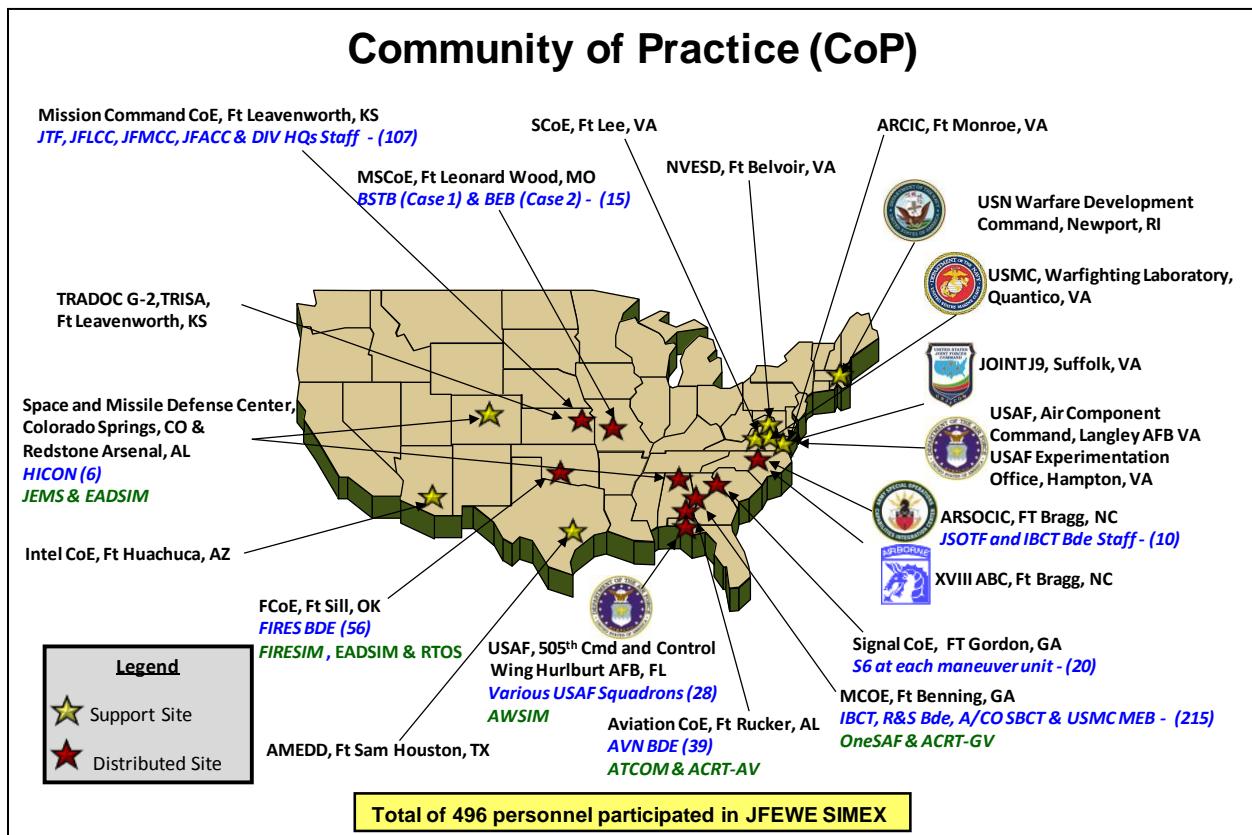


Figure 1. Community of Practice Graphic

Due to the size and complexity of the experiment, planners knew early on in the experiment design process that participants would require a process to follow in the event of simulation or human error.

Importance of Establishing Adjudication Procedures

Many factors can lead to the need for human intervention into the outcomes of the models. The most common examples are unreasonable effects (a bullet fired from a pistol destroys a tank), unrealistic representation (an entity represented as a tank actually

models a pickup truck), terrain not modeled correctly (a bridge which should allow traffic to pass at normal speed across a river stops traffic), and when White Cell [the Experiment or Exercise Control Cell] intervention is required (an enemy unit requires movement to a specific point faster than it would normally move to ensure a scripted event occurs). Additionally, issues involving the inability of simulations to properly integrate with one another may require human adjudication. For example, an aircraft in one simulation can sense ground forces in a second simulation as expected, but the ground forces cannot sense the aircraft even though they should have this ability. Given available time, integration issues should be resolved prior to event execution, but this is not always possible. Reasons for delay in integration may include limited time, technical constraints, or budget limitation. If the integration shortcomings are minor or will not affect experiment objectives, it may be possible to work around the problems using adjudication procedures. Identification of the most possible situations which will require adjudication is the first step in the establishment of adjudication procedures.

Framework for the Establishment of Adjudication Procedures

The following are the six steps to develop adjudication procedures:

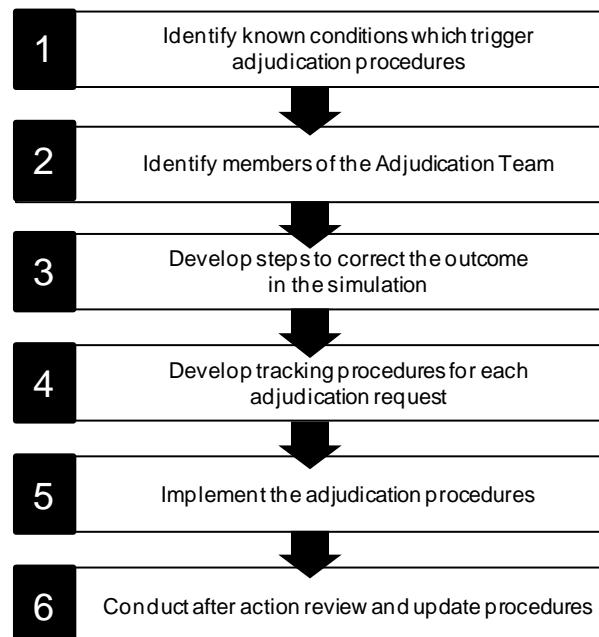


Figure 2. Steps of the Adjudication Procedure

Step 1: Identify Known Conditions which Trigger Adjudication Procedures

There can be numerous circumstances that trigger the use of the adjudication procedures. It is important to identify as many potential situations as possible in order to outline the contingencies and procedures for each set of circumstances. Like all contingencies, the mere discussion of the contingencies ahead of time facilitate resolution when these conditions surface and allow for quicker and ideally better decisions during execution. Consider activities such as fire evacuation plans and giving these presentations in front of audiences. Regardless of how good the plans or presentations are, it takes practice for them to be effective. As previously discussed, the most common situations involve modeling errors. They may also involve secondary effects of those errors. One such example would be if a rifle shoots two rounds of ammunition for each "trigger pull" ammunition will be expended twice as fast as it should be. Procedures may dictate that either resupply of one basic load can be done once it has been reported (further discussion in Step 4) or that the model begins the fight with twice its basic load of ammunition. Situations may exist where weapons effects are not reasonable, or environmental effects are not replicated accurately (terrain, weather and light data, buildings and other structures offer no protection or too much protection, sensors perceiving inaccurately, etc.). The important point is to brainstorm and identify as many contingencies as possible in order to develop the rules for each well ahead of time.

Step 2: Identify Members of the Adjudication Team

The executive agent for the experiment or training event must determine who will have the authority to execute the adjudication procedures. Consider this your umpire team or officiating crew. They should be members of the experiment White Cell; that is to say they are impartial and do not favor either the friendly or enemy forces. That said, there must be representation from both the friendly and enemy forces in order to ascertain the ground truth of an event. The friendly and enemy representatives on the adjudication team should research each request in order to validate the request and ensure conditions and events occurred as reported. During an experiment at the MBL, a blue role player requests an adjudication to reconstitute 15 members of his unit because "an enemy soldier appeared out of nowhere and began shooting." When the enemy forces were asked about the incident, they explained that the soldier who killed the blue forces had infiltrated the friendly position over the course of approximately four hours, undetected by blue forces. In

such situations, one member of the team must be knowledgeable on the technical aspects of the models and simulations being used plus any issues with integration of different models. This team member will know if "unreasonable effects" reports are attributed to the model or not. Additionally, this person may be able to give a technical answer to experiment participants as to why effects were not necessarily unreasonable. For example, the probability of hit or probability of kill calculations may be much different than the participants think that they should be. The leader of the Adjudication Team must be someone knowledgeable with the real world system capabilities involved in the experiment, serve as the ultimate arbiter between the friendly and enemy representatives, and balance their input with the input from the technical representative. A member of the Analysis Team must be on the adjudication team to ensure that input is received for each request so that the impact on the Experiment Objectives is part of the discussion of any adjudication. The result in this appointment is as questions arise during post experiment processing, a member of the Analysis Team can answer why specific adjudications were approved or disapproved. The final member of the team is the recorders who receives all requests, logs them, gives to the team for decision and records the actions taken or not taken regarding each request.

Step 3: Develop Steps to Correct the Outcome in the Simulation

For each of the expected types of adjudications, procedures must be identified that will be taken every time that event occurs. Consistency and validity of data as well as the need for standardization require this. For example, if an aircraft of Paratroopers is destroyed en route to the drop zone due to unreasonable (meaning too effective) enemy air defense fire, there must be procedures for how those Soldiers will be reconstituted, at what location they will come back to life, and if they should remain casualties. If four vehicles are destroyed due to a convoy entering a minefield, and it is determined that under normal tactical situations, one or perhaps two vehicles would be destroyed and the third and fourth vehicles are reconstituted, it must be identified whether the third or fourth will be reconstituted "fresh", with its full load of ammunition and fuel or whether that will be decremented to account for where it was in the fight when they entered the minefield. The same applies for the crew of the vehicles. Depending on the fidelity of the simulation, the adjudication team may have to decide on the amount of food and water to reconstitute. With some simulations, when reintroducing an entity, they must come back at 100% strength. Adjudication Team members should develop standardized

procedures for as many situations as possible to accelerate the process during execution and ensure consistency. The following chart represents the general process used during JFEWE and was used to brief leaders at the Final Planning Conference.

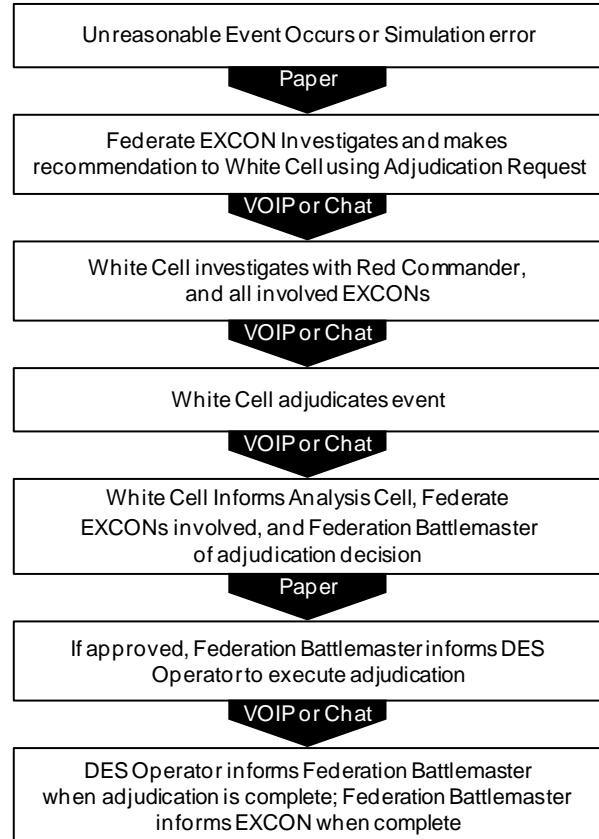


Figure 3. Adjudication Flow

Step 4: Develop Tracking Procedures for Each Adjudication Request

In order to maintain the validity of the experiment and credibility of the data collection process, it is imperative that all requests and actions taken are documented. Detailed tracking procedures usually begin with the simulation interactor or military role player, either friendly or enemy. When they observe an action they feel warrants adjudication, a process must exist for them to submit a detailed request with all pertinent information of the conditions surrounding the event. A vague report such as "our guys keep receiving indirect fire at a volume far in excess of enemy capabilities" is almost impossible to investigate or rationalize. Likewise "one of our tanks just ran out of fuel and should have had plenty of fuel" does not give sufficient detail to warrant adjudication. As a minimum, the Adjudication Team will need the following: The exact time or as close as possible,

entities involved, location stated as accurately as possible, and what exactly is to be adjudicated. For example, if a personnel carrier and all personnel on board were destroyed, it is possible that the requested adjudication is merely regeneration of some of the personnel on board, not the entire number of soldiers killed. In order to facilitate the process, the MBL developed a tracking sheet, the adjudication "buck slip," that each simulation and military role player fills out to begin the process. Figure 4 is an example of the buck slip used during JFEWE by the simulation interactors and military role players.

<u>ADJUDICATION REQUEST</u>	
DTG OF SIM EVENT:	
REQUESTING FEDERATE / CLUSTER:	
TYPE OF REQUEST: RECONSTITUTION / MAGIC KILL/ RESUPPLY / MAGIC MOVE	
BUMPER NUMBER(S) FROM REQUESTING CLUSTER:	
BUMPER NUMBER(S) OF "OTHER" UNIT:	
DTG SENT TO WHITE CELL:	
DECISION:	
DTG EXECUTED:	

Figure 4. Adjudication Request "Buck Slip"

Note that the Buck Slip includes the date-time group (DTG) at when the event occurred in simulation time which may be different from clock time. This is to make the audit process easier for analysts whose tools generally record in simulation time. Once completed, the buck slip is given to the Node Boss of the simulation cluster which represents the unit of the simulation interactor or military role player. The Node Boss reviews it for completeness and gives it to the Federate Battlemaster, the person responsible for the proper operation of the simulation at each Federate. The battlemaster will also review it for logic and completeness and will submit it through his Federate Experiment Control to the Federation White Cell where the adjudication team works. One designated person will serve as the full time recorder, and will record all adjudication requests and actions taken. As the requests are received the recorder will log the request and enter the information into a spreadsheet. The following table (Table 1) was used during JFEWE.

Table 1. JFEWE Adjudication Log with Sample Entries (All Times MST)

Serial	DTG of SIM Event	Requesting Federate / Cluster	Bumper Number from Requesting Cluster	Bumper Number(s) of 'other' Unit	DTG sent to White Cell	Decision	DTG Executed
1	090230 Mar 11	2 MEB	TF HAMMER	12SWG 6418 72327	090230 MAR 11	Ash and trash only (incl 2 x T72s). Situated there at STARTEX NFA at this point	090230 Mar 11
2	10 2316 MAR 11	GORDON	1JA4FATCN01B	1JA4FATCN01B 1J7DIVTRT01B 1JACAVTCN01B	102316 MAR 11	SIGNAL TAC COMMS NODE X 2. Links with Serial 15. Federate BM Master Ft Benning liaising with DES at Monroe to regenerate	102316 MAR 11
4	100014 MAR 11	RUCKER	AH1Z/9 4828972672	N/A	100014 MAR 11	COBRA crashed due to operator being away from stn (due to TORNADO warning yesterday). Request to regenerate made via Fed BM.	100036 Mar 11
5	100005 MAR 11	IBCT A-CO 2-44	UNIT UNKNOWN	1BRZACWM66XR	10020 MAR 11	Entity been engaged with 5.56 and 7.62 Magic Kill requested via Federation battlemaster	100030 MAR 11

This spreadsheet will become critical during post mission analysis as it will help reconcile numerical analysis questions such as lethality and survivability. For example, if during a battle, 10 tanks and their crews were destroyed, but through adjudication 4 tanks

and crews were reconstituted, it is possible that those 4 tanks and crew might be destroyed in later fighting. Depending on the simulation and how data is logged, it might record a total of 14 kills, double-counting the four tanks that were regenerated as a result of the

adjudication. Through detailed record including the use of timestamps and locations for the requests, analysts can conduct their data analysis more accurately. It is important to rehearse the flow of information, and it is recommended that it be practiced during the Pilot or Trial Runs of the experiment.

During JFEWE, both a Federation Damage Effects Server (DES) and High Level Architecture (HLA) Logger were used. The DES provided a single point of adjudication for all engagements within the federation. The HLA Logger recorded all HLA traffic across the network. Both were important tools to investigate validity of adjudication requests. Through examining their logs, the White Cell and Simulation Control validated interactions or engagements and used them to piece together information from what was reported by Blue and Red role players and simulation interactors. Although DES could potentially serve as a standalone system of “instant replay”, it ultimately was seen as a single point of failure and the HLA was used as a redundant system. Even with these tools it is critical to keep the log shown above to have a single point of reference of adjudications and to ensure adjudications are completed correctly. For example, if the regeneration of an entire infantry squad was approved, but when humans completed the regeneration they brought an entire platoon back to life, there would be written confirmation that the regeneration should have been a squad, not a platoon. During JFEWE, adjudications were completed remotely by each experiment federate (in some simulations, even by cluster coordinators). The log accounted for authorized versus unauthorized adjudications. Examples of unauthorized adjudications could be a participant who resupplies his units with ammunition or fuel to speed up the process quicker than it would happen in real life or resurrection of key personnel or equipment that had been legitimately killed by the enemy. In events which a DES or HLA logger is not available or practical, the adjudication log is essential.

Step 5: Implement the Adjudication Procedures

Although it may appear that proper execution of the previous steps would make implementation an easy process, it is always difficult. An umpire or referee has a rule book to follow, but must ultimately make the right call. Experience shows that some adjudications may be easy decisions. Examples include known munitions errors, terrain problems that have been identified prior to execution, and outright cheating on the part of participants. On the other hand, most require research and analysis on the part of the Adjudication Team. Additionally, the decisions must be expedient to avoid a compounding of problems or errors. This

requirement for expediency many times demands fairly fast judgment calls to avoid falling behind in the process, while at the same time maintaining consistency. Redundancy must exist among the team members and back up personnel must be identified to fill in as team members must perform other experimental or administrative functions. Also, contingencies such as illness or other absences must be taken into account and appropriate personnel identified to fill the void. A system should also exist to document new adjudications for which planning was not done; these will be added to the procedures for the next experiment.

Step 6: Conduct After Action Review and Update Procedures

During the experiment, it is critical to conduct daily hot washes, known as after action reviews, for several purposes. First, it is critical to ensure all team members review the day’s adjudications and ensure that all documentation is complete before ending that day’s activities. Generally speaking, most days start off with addressing new administrative issues and consequently there is no time at the beginning of each day for a review of the previous day’s adjudications. Also, the information is still fresh in all participants’ minds if follow up is required to capture all of the data. Second, it is important to review what went well and what went poorly as the team conducted the procedures. Any changes to the procedures should be documented, but no changes should be implemented in the middle of the experiment without consultation with all interested parties. This may include, but is not limited to: the Experiment Director, the customer or experiment sponsor, the Lead Analyst, and all affected federates. If approval is granted to change the procedures, then the process should be formalized and all simulation interactors, military role players (friendly and enemy), and technical support personnel such as the Battlemasters and Node Bosses must be informed of the change. If the change must wait until the next experiment, the change should be made and briefed during the experiment planning conferences during the experiment planning and preparation phases.

Use of the Adjudication Procedures During JFEWE

The Army Experimentation Community of Practice (CoP) [depicted on the next page in Figure 6] successfully planned, coordinated, and executed the JFEWE experiment from June 2010 to March 2011. During that time, the CoP conducted four seminars and three planning conferences to develop the Data Collection Master Plan (DCMP), analysis, tactical scenario, training, simulation, integration, resource,

and manning plans. MBL conducted the FE Seminar (2 - 3 June 2010) to inform the CoP on current and future capabilities and requirements to conduct FE operations against a “near peer” threat with anti-access and area denial capabilities to begin developing the experiment construct, to achieve experiment objectives identified, and to codify organization support and requirements.

As summarized in the JFEWE Final Report, the CoP successfully conducted the JFEWE simulation exercise (SIMEX) from 28 February to 17 March 2011 and concluded with a Senior Leader Seminar (SLS) to ARCIC Director on 18 March 2011. Participants used an approved Multi Level Scenario (MLS). The

operational environment consisted of the full range of combat operations consistent with tactical operations during 2018 time frame against a “near peer” enemy with anti-access and aerial denial capabilities. During the execution of the SIMEX, nine organizations provided the distributed environment via the Battle Lab Collaborative Simulation Environment (BLCSE) network, which integrated five simulation models and various Command and Control Systems.

The following figure lists specific models, simulations and supporting tools used at the various federates. Preparation of a similar reference is critical for completion of Steps 1 and 2 of the Adjudication Process and helps to identify participants in Steps 3-6.

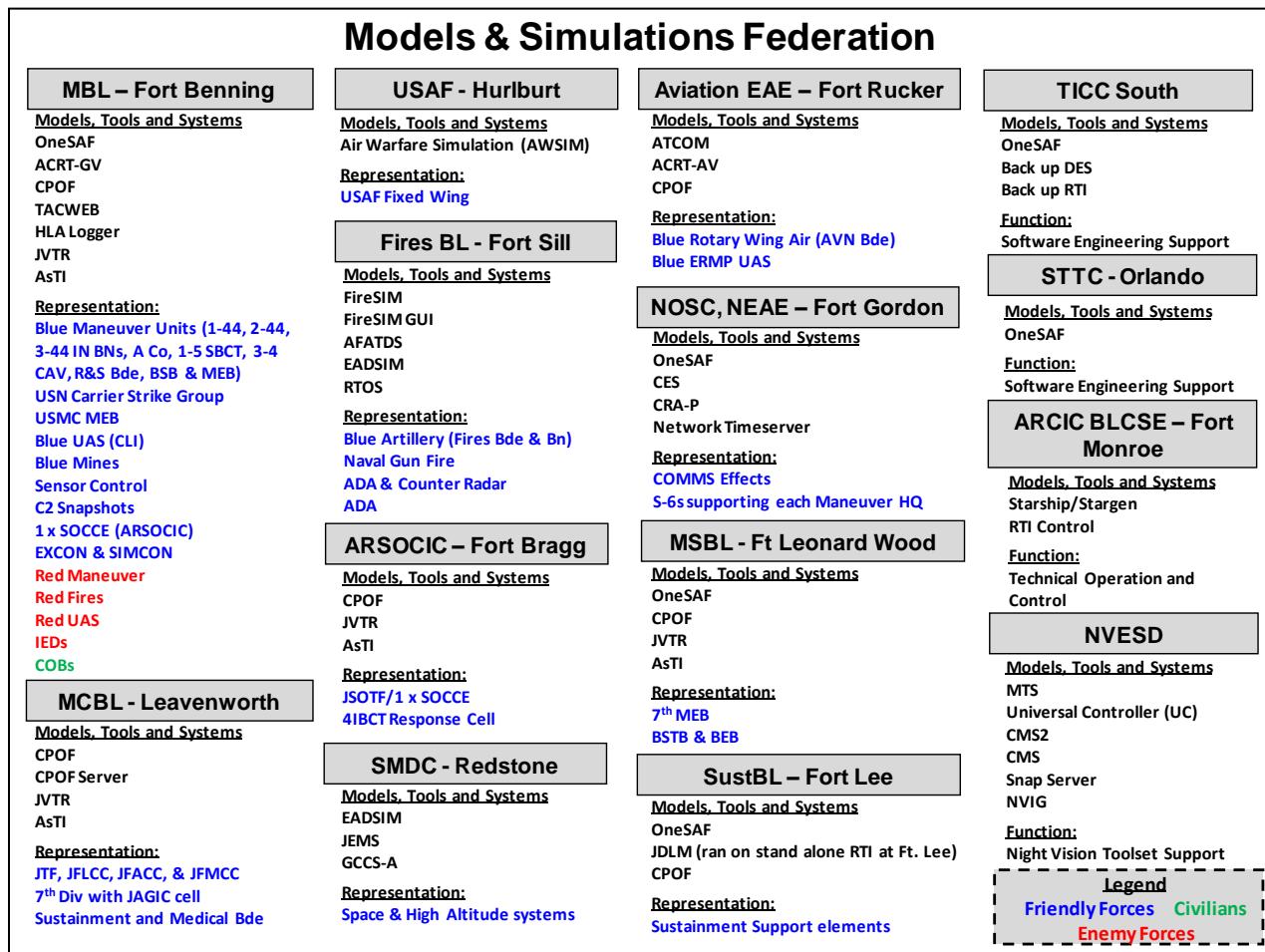


Figure 6. Models, Simulations, and Support Tools

LESSONS LEARNED- The following are areas of the Adjudication Procedures which needed improvement during or as a result of JFEWE

Leaders must enforce the progression of requests.
At the MBL, as simulation interactors and role players

became more familiar with the experiment construct and how adjudications decisions were made, they short circuited the process and went straight to the simulation control or white cell with their requests. This left the node boss and cluster coordinator out of the process and they may have had input (possibly

beneficial) from a technical standpoint that could not be entered into the decision process. Additionally, this causes practical problems when individuals are entering the work area of the White Cell to argue their case. They obviously are not at their assigned duty station as the simulation run continues and there may be information such as MESLs or enemy disposition that role players should not see. It is important in all venues to review the established adjudication procedures to ensure they are responsive and provide feedback to the experiment participants. It is equally important to enforce those procedures during experiment execution.

All personnel must be consistent in the completion of documents (logs and buck slips). Even with the best tracking tools in place, discipline is required in the implementation to ensure all documents are completed in their entirety and with as much detail that is known at the time of the report. Many of the buck slips submitted during the execution of JFEWE were incomplete or did not make sense to the reader. The completed buck slip should leave no doubt as to who was involved and what the requested adjudication is. The buck slips feed into the adjudication log and the same principles hold true for completing it, it must “tell the story,” account for what actions were taken (or not), and a justification for the actions taken. Analysts will refer to the log to ensure proper accounting for entities or supplies that were brought back or reconstituted as the result of adjudication. In the case of JFEWE, an area in which to improve in the future would be the narrative remarks to spell out exactly what happened and a justification.

Adjudication decisions must be evident to all federates. During JFEWE, there was no mechanism to inform all federates (the EXCONs) of adjudication decisions. All of those who were involved in a specific adjudication were informed, but there was not a SharePoint or distributed tracker. In many cases, the method used was sufficient and informed all necessary parties. However, there are many instances either for necessity or for informational purposes that all federates should have access to the information. One example would be if enemy air defense systems were destroyed by friendly artillery and then restored as the result of adjudication. Not only would the enemy forces and the friendly USAF role players need this information (otherwise they would be operating under the premise that the enemy air defense is weaker than it really is), but the USMC and Army role players will also need that information. The information would also be important for intelligence analysts who may be tracking enemy air defense strength system-by-system.

LESSONS LEARNED- The following are procedures to sustain or that validated the use of the adjudication procedures.

The adjudication procedures allowed for experiment execution, even though several simulations had integration problems. Due to various reasons beyond the scope of this paper, the effects of some simulations were not visible or had significant delay in appearing in other simulations. For example, friendly Air Force aircraft would engage enemy personnel or weapons systems but would not be able to determine if their attack was successful or not, such as when the simulation portraying the friendly aircraft did not model individual combatants (Soldiers, insurgents, civilians) or obscurants (the coverage of buildings). Through the use of the adjudication procedure, the adjudication process was followed and feedback was provided to the Air Force experiment control members. Additionally, a target which was attacked and would have suffered damage under real conditions was appropriately damaged or destroyed using the adjudication procedures. Although the adjudication procedures were originally designed to handle issues that would arise on a case by case basis, the procedures also served well for systemic shortcomings in models, allowing for an efficient and predictable workaround.

Documentation must exist for all human interventions and overrides of the simulations. The purpose of the adjudication log is to provide the analyst team a record of human intervention into the simulation results. Consequently, it serves as a practical tool to document any intervention, including those from the Master Scenario Event List (MSEL) (as defined below) or if changes were made to the simulation conditions to achieve experiment objectives. For example, if an enemy unit is rendered combat ineffective through combat, its presence may be necessary so that the friendly forces can continue to operate in order to gain insights into their operations. In this case, the Experiment Director may determine that even though the loss was through logical and realistic engagements, the enemy units should be regenerated. In this example, using the adjudication log is a practical method to ensure that the human intervention is accounted for during post-experiment analysis. As mentioned earlier in the development of procedures discussion, it also ensures that the adjudications were completed correctly, so that a platoon was not resurrected when only a squad should have been.

The adjudication procedures were nested closely with actions injected by the White Cell from the Master Scenario Event List, providing more realism for the participants and better tracking by the analysis team. The purpose of the MSEL cell is to ensure execution of events that may not occur through the natural events of the experiment runs. For example, if the medical community requires a mass casualty to study the ability of friendly forces to conduct large scale medical evacuation, it is very possible that no single battle produces a mass casualty event. In that case, the MSEL team would establish a time and location to introduce a mass casualty event among friendly forces. Although closely related to the adjudication cell, the MSEL cell is a separate group, but must closely coordinate their actions so detailed records are maintained and the experiment does not become desynchronized. During JFEWE, the two cells were co-located and their coordination and knowledge of each other's actions facilitated experiment execution.

CONCLUSIONS AND RECOMMENDATIONS

The JFEWE validated the use of adjudication procedures as a means to account for model and simulations shortcomings and facilitate experiment White Cell actions. Of the eight Experiment Objectives identified earlier, the adjudication procedures facilitated accomplishment of three: Step 1) Focus on the operational problem of Anti-Access with a significant tactical force (Multiple BDEs/DIV force), Step 2) Critically explore and assess concept supporting ideas and required capabilities in challenging operational environments to revise Army concepts to drive capability development in the 2018-2026 timeframe, and 3) Conduct the experiment within a joint context/problem to inform and exercise JFCOM's draft JOA Concept as they allowed for consistent employment of friendly fixed wing aircraft employment and effects, as well as effects of enemy anti-access weapons against friendly Joint assets (Naval and Air). As demonstrated in this paper, it is critical to clearly establish how and when the procedures are implemented for each experiment, who will be involved in the decision concerning the adjudication and, most importantly, how the approvals and denials of the adjudication requests will be documented. Once an initial draft of procedures is designed, it is important to staff them with all stakeholders to ensure they are complete, flow logically and are easily understood by expected participants.

Several topics discussed in this paper lend themselves to future research and documentation by modeling and

simulation professionals. Perhaps the most obvious topic for further investigation comes from the opposite mind-set; that during an experiment, models and simulations should run in whatever state they exist and humans should not override them. Another topic for research may be the development of an electronic system that spans from request to decision and post experiment analysis, which would benefit both the experimentation and training community of practice. Research into the analysis of these or similar adjudication procedures in a more data-centric constructive simulation venue such as a material or procurement-oriented investigation would provide useful insights or guidelines that might be different from a venue like JFEWE which is more concept-focused. In closing, it is recommended that the different communities of practice consider documentation and sharing of internal adjudication procedures and leverage existing SharePoint and knowledge management systems to facilitate information exchange. Open collaboration and sharing of lessons learned through experience and refinement will benefit all agencies involved in constructive and virtual simulation events.

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